

SOVIET-FRENCH WORKING GROUP "INTERPRETATION OF THE SCIENTIFIC  
INFORMATION DURING THE SEARCH FOR CELESTIAL SOURCES OF GAMMA  
PULSES", ABSTRACT OF REPORTS (24-30 MARCH 1977)

I. V. Estulin et al.

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16. Abstract The progress made by the Soviet-French group in the study of gamma-pulses and X-pulses is synopsized in numerous reviews of reports. The experiments included calibration and operation of various recording instruments designed for measurements involving these pulses, specifically the location of sources of such pulses in outer space. Space vehicles are utilized in conjunction with ground equipment to accomplish these tests.					
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I. V. Estulin

TASKS OF THE SOVIET-FRENCH WORKING GROUP

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For several years, a number of specialists in the USSR and France have been involved in the preparation of an elaborate, complex experiment on the study of X- and gamma-pulses. The work was carried out by technical specialists of various skills, physicists, and mathematicians, and astronomers are presently being associated with the work. The time has come to sum up the preliminary results of the work performed, discuss the results obtained, and outline the necessary additional studies.

The final tests of the flight models of the RGS-1M, "Sneg-2MP", and "Sneg-3" instruments will be conducted in the coming months. The accomplishment of an experiment with these instruments is planned in the second half of 1977, and the scientific information will begin to become available to the physicists and mathematicians. It is necessary to ascertain the degree of preparation for processing of the scientific information, and make the appropriate decisions.

O. F. Prilutskiy, V. V. Usov

STATUS OF AND PROSPECTS FOR STUDIES OF PULSES OF COSMIC GAMMA-  
AND X-RAYS

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Discussed in this report are the results of observations of pulses of high-energy X- and low-energy gamma-rays. These data indicate that pulses of high-energy radiation of different types exist. The sources of some pulses are known to be located

\*Numbers in the margin indicate pagination in the foreign text.

inside of the Galaxy; the nature of others is as yet unknown. Both galactic and metagalactic models of pulses are examined briefly. Experiments, which could help to ascertain the nature of pulses of high-energy X- and gamma-rays, are discussed in the conclusion of the report.

B. V. Komberg, I. V. Estulin

SYNCHRONOUS OBSERVATIONS IN ROENTGENS AND IN OPTICS

A review is given of the literature on X-ray observations of optical variable stars of different types. Based on the parameters of the "Sneg-2MP" apparatus, the possibilities of detecting a roentgen during stellar bursts of different natures and the advisability of synchronous photographic observations with a wide-angle optical device are discussed. A list of variable stellar objects, recommended for synchronous electrophotometric observations, is examined; these objects have a maximum brightness beyond 10, and are located in the band around the ecliptic zone ( $\pm 10^\circ$ ), scanned by the "Sneg-2MP" instrument. The list also includes identified roentgen objects, spherical clusters, and a number of weaker flaring and peculiar stars.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
METHODS OF OBTAINING THE SPECTRA OF  $\gamma$ -QUANTA ACCORDING TO THE SPECTRA OF ELECTRONS MEASURED IN NaI AND CsI CRYSTALS (Methods Used for Analyzing the Results of the "Opal" Experiment on  $\gamma$ -Astronomy, Conducted in a Balloon)

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The program presented here makes it possible to find the energy spectrum of the  $\gamma$ -quanta entering a detector, based on the amplitude spectra produced by NaI and CsI crystals. A library, compiled from the experimental data of calibrated radioactive sources, makes it possible to obtain information on the energies of  $\gamma$ -quanta by means of interpolation using cubic spline functions. This interpolation is a matrix of the detector's response. Using this matrix and the iterative method, one can obtain the energy spectrum of the  $\gamma$ -quanta

entering the detector.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
RESULTS OF CALIBRATING THE "SNEG-3" AND "SNEG-2MP" SCIENTIFIC  
EQUIPMENT FOR THE EXPERIMENTS

Calibration of the "Sneg-3" and "Sneg-2MP" scientific equipment for the experiments consists of obtaining the characteristics of the detectors for different  $\gamma$ -quanta energies and for different angles of their incidence with respect to the detector.

The characteristics of the detectors for different  $\gamma$ -ray energies and different angles of incidence will be obtained by means of interpolation of the experimental characteristics.

Described in the reports are the mechanical and electronic devices utilized for these calibrations, the characteristics of the  $\gamma$ -ray sources used, the selected measurement angles, and examples of experimental data for some angles and energies.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
PROBLEMS ASSOCIATED WITH THE SEARCH FOR THE DIRECTION OF  $\gamma$ -  
PULSES, ACCORDING TO THE INFORMATION INCOMING FROM SEVERAL  
SPACE VEHICLES

Examined in the report are problems of accuracy with localization of  $\gamma$ -pulses. Methods are set forth in the report which determine the direction of approach of the pulse and the accuracy of determination of this direction, as a function of our knowledge of the position of the satellites and the accuracy obtainable with comparison of the signals. The results of calculations for the "Sneg-2MP", "Sneg-3", and "Gelios" experiments are given.

A program is described for studying the correlations, based on the measurement of the correlation factor between sig-

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nals, assuming a non-linear correlation in order to preclude part of the physical sources of errors.

The previous program is verified by the Monte Carlo method for pulses of Gaussian form, and different pulse shapes, backgrounds, and calibration peaks are obtained with a fine time resolution of from 2 to 10 ms.

B. L. Novak

DETERMINATION OF THE TIMES OF PASSAGE OF DIFFERENT POINTS IN OUTER SPACE BY A  $\gamma$ -PULSE

The procedure for determining the celestial coordinates of  $\gamma$ -pulse sources, which is based on the utilization of some space vehicles (KA), requires quite precise knowledge of the times of passage of different points in outer space by pulses.

In this connection, the problem occurred of the accurate determination of these times or the problem of determining the lag time  $\tau$  of pulse passage, which is the same thing. If the time spectra coincided on various vehicles, then the task of their identification, and consequently of finding  $\tau$  as well, would be trivial. However, such coincidence does not occur, even with the utilization of identical detectors. The most important reasons for this are:

1) Spectra have a discrete nature, and the position of the recording interval boundaries relative to the signal itself, generally speaking, do not coincide on different vehicles (non-synchronization of spectra).

2) Radiation has a probability nature, and, consequently, the probability of coincidence of spectra is quite small, even in the case of their synchronization.

All of this leads to errors in the determination of  $\tau$  by any method. With the determination of  $\tau$  utilizing the "Pulse"

signal, these errors can be unacceptably large. This method is analyzed in the report, and the maximum possible error in determining  $\chi$  is evaluated.

The indicated circumstance forces one to turn to the methods based on the full utilization of measurement information. We propose to find  $\chi$  with the minimization

$$\chi^2 = \sum_{i=1}^m (w_{i,j}^{(u)} n_{i,j}^{(u)} - w_{i,k}^{(u)} n_{i,k}^{(u)})^2,$$

where  $n_{i,j}^{(u)}, n_{i,k}^{(u)}$  is the count in the detectors located on two space vehicles;

$w_{i,j}^{(u)}, w_{i,k}^{(u)}$  are statistical weights;

K is the evaluation for the maximum possible error in determining  $\chi$ , utilizing the "Pulse" signal;

m is equal to M-K;

M is the number of measurements.

The accuracy of the method is investigated in the report, and the results of processing the ground tests of the "Sneg-2M" instrument are given.

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G. A. Mersov

ALGORITHMS OF LOCALIZATION OF CELESTIAL SOURCES OF X- AND  $\gamma$ -PULSES, USING SEVERAL SPACE VEHICLES

For localization, values of the passage lags of pulses at different points in outer space are utilized. It is assumed that space vehicles (KA), which record the pulse, are located at these points. Cases of the utilization of 2, 3, and 4 space vehicles are examined. The algorithms of localization of both the source of a spherical wave and the source of a flat wave are obtained. In the first case, the direction and distance to the source are determined, and in the second case—only the

direction. The accuracy of localization and its dependence on the relative location of the space vehicles are studied. An expression is obtained for the maximum distance to the source of a spherical wave, which can be determined with a given statistical reliability.

N. A. Eismont

UTILIZATION OF INFORMATION ON THE MOVEMENT OF A SPACE VEHICLE  
NEAR THE CENTER OF MASSES IN THE PROBLEM OF LOCALIZATION OF SOURCES  
OF X- AND  $\gamma$ -PULSES

The problem of localizing sources of X- and  $\gamma$ -pulses can be, as is common knowledge, solved by means of installing the appropriate monitors on several space vehicles (KA) conveyed in space. In this case, the complete determination of the coordinates of the source is possible, as a rule, only with the utilization of 4 space vehicles. In the case of utilization of 2 or 3 space vehicles, it is necessary to draw on supplementary information. Data on the movement of space vehicles near the center of masses can be utilized as such information.

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In the case of utilization of the space vehicles planned for the experiments, this movement can be described as movement according to Euler-Poinsot. The utilization of the characteristics of movement of space vehicles leads to the rather simple approximation of the functions which describe the movement, and, accordingly, to the rapid algorithm for processing the telemetry information from the optical monitors of space vehicle position. The position of the space vehicles relative to the center of masses, at any given moment in time, is determined from the results of this processing. If the monitors utilized in the experiment, which record X- and  $\gamma$ -pulses, have characteristics which depend on the direction of approach of the radiation, with the axes of the directivity diagram not coinciding, then the knowledge of the angular position of the space vehicles in space makes it possible to clear up the uncertainty of source localization.



On the other hand, if the location of the source is known, then one can, in many cases, carry out calibration of the instrument, and then utilize the information received from the instrument in order to make the angular position of the space vehicles more precise.

Thus, combined processing of the measurements from the optical monitors of space vehicle position and the X- and  $\gamma$ -ray monitors, with the use of the dynamics of movement of the space vehicles relative to the center of masses, can be quite useful, in that it expands the possibilities of localizing the sources of X- and  $\gamma$ -pulses.

I. V. Estulin, G. I. Zabiyaikin, Ye. M. Vasil'ev, A. Yu. Bergman, Ye. D. Gernet, A. V. D'yachkov, V. M. Zenchenko, B. S. Novikov, I. D. Skobkin, E. R. Cherkasova  
METHODS FOR COMPUTER PROCESSING OF THE RESULTS OF TESTS OF INSTRUMENTS FOR RECORDING  $\gamma$ -PULSES

A procedure is examined, which was developed at the Institute of Space Research of the Academy of Sciences of the USSR, for computer processing of the results of tests of pulse instruments in the mode of direct transmission of information, at the rate of the tests of an instrument. The information from the instrument enters a "space vehicle simulator", and then along a communications line into an M-6000 computer via a junction device. A special organizing program controls the input of information to the computer, and, after the appropriate analysis, these data are produced on an analog-digital display or alphanumeric printer, and recorded onto standard magnetic tape suitable for processing on the multi-purpose computers of the Institute of Space Research of the Academy of Sciences of the USSR. The magnetic tape enters the ES-1030 computer formed in a standard structure for final processing. Each measurement is processed, energy and time spectra are constructed, and the calibration values and average magnitudes of background radiation are derived.

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The procedure was tested during tests of the "Sneg-2M3" technological instrument.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
PROCESSING OF INFORMATION FROM THE "SNEG-3" EXPERIMENT

Processing of the information from the "Sneg-3" experiment will be carried out in 4 stages, in accordance with different purposes. The first three stages of processing (TR, TQ, TS) of part of the data will be carried out very rapidly; the last stage of processing (TD) of all of the data will be carried out with a two-month offset.

With processing in real time (TR), the technological parameters and control channels of the experiment are indicated sequence after sequence, with the establishment of direct communications with a satellite. This type of processing makes it possible to control implementation of the televised instructions.

With daily processing (TQ), the data is processed in orbit, and this makes it possible to control the different components of the experiment. Even with this type of processing, intense sources can be detected. Then, the frequency of inclusion of "pulse" units is calculated.

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Weekly processing (TS) makes it possible to gather data and control the shifting of the detector indicators. In this case, intense sources can be approximately localized and a background of cosmic origin can be determined.

Finally, after completing data collection, final processing (TD) is carried out, which makes it possible to conduct fine localization of sources and determination of their spectrum, as well as the detailed study of the diffuse background and the

study of the time structure of  $\gamma$ -pulses.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
STAGES OF CONDUCT OF PROCESSING INFORMATION FROM THE "SNEG-2MP"  
EXPERIMENT

Presented in the report is a general plan for organizing the programs intended for processing the data of the "Sneg-2MP" experiment. This processing system, which will be utilized systematically for processing all of the data, consists of:

- a program which determines the levels of the energy ranges measured, using calibration, in the flight position;
- a program which regenerates the spectra of the  $\gamma$ -quanta on the basis of observable spectra;
- a program for Fourier analysis;
- a program for constructing curves.

The principles of operation of these programs are set forth, along with the condition in which they are found.

Ye. A. Gavrilova  
SYSTEM FOR PROCESSING THE DATA FROM THE "SNEG-2MP" EXPERIMENT

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A system is examined for the preliminary processing of telemetry data on objects of the "Prediction" type. The tasks of this stage of processing amount to the following: input of telemetry information into the computer and preliminary analysis of the quality; regeneration of standard telemetry structure with localization of the sites of irregularities; correlation of scientific information with Moscow time, marking of segments of low-speed commutator, and arrangement of information in order of increasing time of storage.

In order to process the information from the "Sneg-2MP" experiment, the following tasks are covered: sorting of experimental data; determination of operating conditions; processing of background measurements from the S, 1L, and 2L detectors;

processing of calibration characteristics of the detectors; establishment of a collection of pulse events, with regard for the data on radiation zones on the magnetic tapes; processing of the pulse data.

The determination of the processing stages is substantiated. The content of the processing stages is examined in detail, along with matters of control and direction of the processing process.

A. V. D'yachkov, V. M. Pokras

PRELIMINARY AND PRIMARY PROCESSING OF DATA OF THE SOVIET-FRENCH  
EXPERIMENT "SNEG-2M3"

The preliminary and primary processing of the data from the "Sneg-2M3" experiment includes fulfillment of the following tasks:

- the input of telemetry data into the computer, and their preliminary analysis;

- localization of irregularities in the structure of the telemetry data and establishment of groups of regular structure with characteristics which determine their quality;

- decoding of the flight time channel, and its determination for each scientific program;

- separation of data from the "Sneg-2M3" experiment, according to the working characteristics of the telemetry system;

- determination of the Moscow time of the measurements for each sample of the "Sneg-2M3" instrument.

It is assumed that the navigational correlation of the data is accomplished during subsequent processing, with the association of navigational and telemetry data being carried out using the Moscow time of the measurements in each sample.

Subsequently, the data of the control calculation is separated out, and the energy spectra constructed according to these data.

The time function of the energy in a certain energy range is constructed in order to determine the nature of the pulse. These data are produced in print and in graphic form for visual analysis.

At the same time, pulse information is separated out and divided into data obtained from various of the instrument's storage units.

Control and regeneration of the structure of the data from each storage unit are carried out. Then, the data from each storage unit are processed, including the obtaining of energy and time spectra.

This information is produced in print and in graphs, and stored in the collection of data for the experiment.

The informational unit in the data collection is the pulse. The information on each pulse includes the data from all of the storage units, as well as the obtained time and energy spectra.

Each pulse has its own identifier, which also makes it possible to unequivocally select any pulse obtained from other devices taking part in the experiment.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
GROUND CONTROL SYSTEM FOR "SNEG-3" EXPERIMENT

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Control of the operation of the scientific equipment carrying out observations in the area of  $\gamma$ -astronomy ("Sneg-3" experiment) is accomplished according to the telemetry data entering the T-1600 computer. Different types of processing can be carried out:

1) Observation. This type of control makes it possible to check the telemetry information sequence after sequence, and check the change in some parameters as compared with the original

data.

2) Revealing the total information contained in one telemetry sequence. Such revealing makes it possible to control the conduct of:

- electrical tests;
- functional tests.

3) This test (physical test) is carried out on 40 or 100 telemetry sequences in the presence of a radioactive source, and makes it possible to check the operation of the detector by means of determining the position of the peak of absorption of the total energy of the gamma-quanta.

Given in the report are the characteristics of the systems used for conducting the ground tests, and methods are set forth for conducting these tests and processing the test results.

A. R. Bazer-Bashi, Zh. Shanbon, K. Orli, M. Niel, Zh. Vedren  
GROUND CONTROL SYSTEM DURING THE CONDUCT OF THE "SNEG-2MP"  
EXPERIMENT

The "Sneg-2MP" instrument feeds the values of the parameters into the "Mikral'" computer in analog form. Two types of processing are conducted, based on the data entering the "Mikral'":

1. Transformation from analog form into digital and approximate classification, producible by the "Mikral'" mini-computer, make it possible to reveal all of the data directly on a teletype in a decimal code.

2. The "Mikral'" computer codes the information in pulse-code modulation, adds statuses, and clears the storage onto mini-cassettes for a Sony tape recorder. Then, the information can be processed in the "Mitra-15" computer.

Reported in this article are the characteristics of the systems used to carry out the ground tests, the conduct of these tests, and the processing of the test results.

A. V. Kuznetsov

RESULTS OF TESTS OF THE "SNEG-2MP" TECHNOLOGICAL INSTRUMENT

Data are given on the operation of the "Sneg-2MP" technological instrument both in autonomous tests, and on a satellite in the period from July 1976 to February 1977.

Matters of the energy calibration of the detectors are examined, along with the operation of time devices and their accuracy, the possible dependence of the operation of the time counter on the frequency pattern, and the linearity of the instrument's telemetry scale.

Supplementary physical tests of the instrument on the satellite are discussed. Recommendations are given for evaluating the operation of the instrument. The test materials are utilized to prepare programs for processing the experimental results.

O. B. Likin, N. F. Pisarenko

SOME CHARACTERISTICS OF THE RF-2P INSTRUMENT

The physical parameters of the RF-2P X-ray photometer are set forth: angular aperture and area of detector and its effective registration of X-rays in the 60-100 kilo-electron volt energy range, dynamic range of the counter's speed recorder, and characteristics of the output circuits of the counting device. /16

The possibilities of correlative comparison of the readings of the RF-2P instrument with the data of the "L" detector of the "Sneg-2MP" instrument are discussed.